SHORT COMMUNICATION

DETERMINATION OF THE NUMBER OF LARVAL INSTARS OF *APION ULICIS* (FORSTER) (COLEOPTERA: APIONIDAE)

M.S. HODDLE[1]

Department of Zoology, University of Auckland, Private Bag, Auckland, New Zealand.

(Received 19 June, 1990; revised and accepted 4 September, 1990)

ABSRACT

Hoddle, M.S. (1991). Determination of the number of larval instars of *Apion ulicis* (Forster) (Coleoptera: Apionidae). *New Zealand Natural Sciences* 18: 63-66.

Gorse is an economically important weed in many countries. To contain its spread the gorse seed weevil *Apion ulicis* (Forster) has been introduced. Some aspects of the bionomics of this insect have been studied previously, but the number of developmental instars has not been determined. A Mixture Analysis has indicated that *A.ulicis* has three larval instars in New Zealand.

KEYWORDS: *Apion ulicis* - instar determination - *Ulex europaeus* L. - New Zealand - lifetable.

INTRODUCTION

Gorse, *Ulex europaeus* L. originates from the west coast of Europe and Northern Africa (Holm *et al.* 1979). Today it is found in 17 countries outside its area of origin (Markin & Yoshioka *in press*). It is a serious weed in New Zealand (MacCarter & Gaynor 1980), northwest Spain (Hill 1987), Chile (Nourambuena *et al.* 1986), parts of the mainland of the United States of America (Holloway 1957) high altitudes in Hawaii (Markin *et al.* 1988), and southern Australia (Wilson 1960).

Gorse was originally introduced into these countries for hedging, as a fodder crop and to nitrogenise poor quality soils. As these uses were beneficial, early biological control programmes aimed to reduce the invasiveness of this weed by minimising the amount of seed set annually, rather than to eradicate it. The agent utilised for this was the host specific gorse seed weevil *Apion ulicis* (Forster). The developing larvae of this weevil consume the immature gorse seeds and complete their life-cycle within the gorse pod. The adult weevils are liberated when the pod dehisces.

Strains of this weevil from England or France have been liberated in Australia, Chile, Hawaii, New Zealand and the United States of America. The bionomics of this weevil have been investigated by Davies (1928) and Forster (1977) but neither determined the number of instars this weevil has in New Zealand or elsewhere.

MATERIALS AND METHODS

In New Zealand, *A. ulicis* larvae are found in pods from October to mid December (Cowley 1983). For this study, gorse pods were collected from a sampling site at Whitford, in South Auckland, from October to the end of November 1989. Sampling ceased when pupae were found. Collected pods were opened and examined under a dissecting microscope. Head capsule widths and lengths were measured using an ocular micrometer on a Wild M8 stereo microscope at x25 magnification. A total of 219 larvae were measured.

A Principle Components Analysis (P.C.A.) was performed on these measurements using SAS (Proc-Princomp; Sas Institute Inc 1987) on an IBM-PC. The proportion of the variance explained by the eigenvalue for the first principle component was 0.9692. The transformed data were grouped into 22 classes and an Interactive Programme for Fitting Mixtures of Distributions

[1] Present address: Plant Protection Research Unit, Lincoln University, PO Box 94, Lincoln, Canterbury, New Zealand.

(Mix 2.4 Icthus Data Systems 1988), was performed to ascertain instar number from size frequency data. The distributions were fitted using the Quasi-Newton iterative algorithm. The details of this type of analysis have been explained by MacDonald & Pitcher (1979).

RESULTS AND DISCUSSION

The mixture analysis revealed 4 putative classes. The first two of which are distinct (Fig. 1), but an overlap occurs between class 3a and 3b. A Chi Square Goodness of Fit Test was not significant at the 1% level indicating that the observed classes seen in Fig. 1 approximated the expected classes from the data ($X^2 = 18.5, df = 7, P > 0.01$).

A small proportion of the sampled population (0.03) falls into class 3a (Fig. 1). It may be possible this size class is an artefact of sampling. It is unlikely that 3a is evidence of sexual dimorphism before pupation, as the female:male sex ratio of adult weevils in the pod prior to dehiscence is 1.01:1.00 (Forster 1977). This relationship is not evident between classes 3a and 3b.

The individuals of class 3a are small, third instar larvae. The relationship of head capsule size and larval density per pod were not recorded, but data for the weight of adult weevils with respect to density over the same season was. Individuals from low (fewer than 6 weevils in a pod) and high density pods (greater than 6 weevils in a pod) exhibit a reduced weight, which is realised by a smaller size. This would infer that larvae from these pods would have head capsule dimensions reflecting this (Hoddle 1991).

If class 3a (Fig. 1) is omitted Dyar's Law (Dyar 1890) is adherred to and a consistent ratio of head width increments is obtained (Table 1). This indicates that head capsule development in *A. ulicis* follows a regular geometric progression in successive instars, and substantiates the fact that an instar has not been overlooked (Imms 1951).

CONCLUSION

It is proposed that *A. ulicis* in New Zealand has three larval instars. This result may not necessarily apply to *A. ulicis* in other countries as tem-

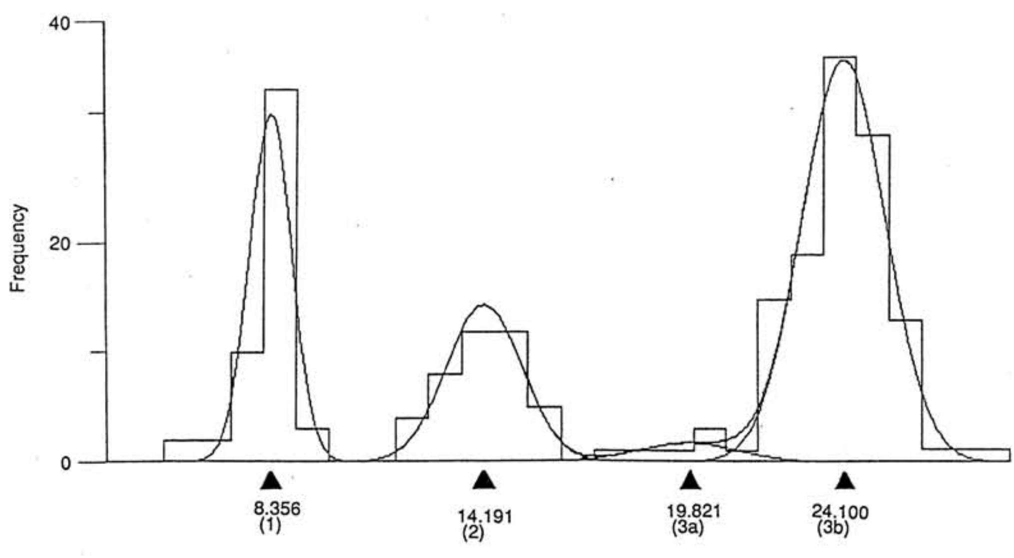

Figure 1. Headcapsule width frequency histogram for *Apion ulicis*.

Table 1. Instar sizes (mm) and inter instar ratios of field collected *Apion ulicis* larvae.

Instar No.	Mean Headcapsule width (mm)	± SE	Inter Instar Ratio (Dyars Constant)
1	0.153	0.0075	
			0.586
2	0.261	0.0058	
3a*	0.351	0.0145	
			0.588
3b	0.444	0.0065	

* This row has not been used for the calculation of Dyars constant. See text for explanation.

perature can affect instar number (Zenner-Polania & Helgessen 1973) as can photoperiod (Morris 1990). These phenomena will need further investigation.

The result of this study provides the necessary basis for lifetable construction for *A. ulicis* as the number of lifestages are known. Survivorship in each lifestage can be investigated and key factors determined, allowing a more accurate estimate of the role *A. ulicis* plays in gorse population dynamics. It's success and potential as a biological control agent can then be assessed.

ACKNOWLEDGEMENTS

I am grateful to Dr A.G. Rodrigo for statistical advice, constructive criticism and inexhaustable patience while preparing this script, Dr B.H. McArdle for statistical advice, Dr D.R. Cowley and Dr J.M. Cowley for constructive criticism of the script. Mr and Mrs P. McNealy of Whitford kindly consented to the regular sampling of gorse pods from their property. This research was supported by a DSIR Plant Protection Studentship.

REFERENCES

Cowley, J.M. (1983). Lifecycle of *Apion ulicis* (Coleoptera: Apionidae) and gorse seed attack around Auckland New Zealand. *New Zealand Journal of Zoology* 10: 83-86.

Dyar, H.G. (1890). The number of moults of Lepidopterous larvae. *Psyche* 5: 420-422.

Davies, W.M. (1928). The bionomics of *Apion ulicis* Forst. with special reference to its role in the control of *Ulex europaeus* L. in New Zealand. *Annals of Applied Biology* 15: 263-285.

Forster, J.M. (1977). Aspects of the biology of *Apion ulicis* (Forster). MSc Thesis, University of Auckland, New Zealand.

Hill, R.L. (1987). The biological control of gorse (*Ulex europaeus* L.) in New Zealand. *An Environmental Impact Assessment. Entomology Division D.S.I.R. Report*.

Hoddle, M.S. (1991). The reproductive biology of *Apion ulicis* (Forster) (Coleoptera: Apionidae). MSc Thesis, University of Auckland, New Zealand.

Holloway, J.K. (1957). Establishment of seed weevil *Apion ulicis* Forst. for suppression of gorse in California. *Journal of Economic Entomology* 50: 498-499.

Holm, L., Pancho, J.V., Herberger, J.P. & Plucknett, D.L. (1979). *A Geographical Atlas of World Weeds. Wiley Interscience*, 399 pp.

Icthus Data Systems (1988). Mix. Release 2.4. Ontario Canada.

Imms, A.D. (1951). *A General Textbook of Entomology*. Edition 8, Methuen, 727 pp.

MacCarter, L.E. & Gaynor, D.L. (1980). Gorse a subject for biological control in New Zealand. *New Zealand Jouarnal of Experimental Agriculture* 8: 321-330.

MacDonald, P.D.M. & Pitcher, T.J. (1979). Age groups from size frequency data: a versatile and efficient method for analysing distribution mixtures. *Journal of the Fisheries Research Board of Canada* 36: 987-1001.

Markin, G.P. & Yoshioka, E.R. *in press*. Present status of biological control of the weed gorse (*Ulex europaeus* L.) in Hawaii. *Proceedings of* *the VII Syposium on the Biological Control of Weeds, Rome, Italy.*

Markin, G.P., Dekker, L.A., Lapp, J.A. & Nagata, R.F. (1988). Distribution of the weed gorse (*Ulex europaeus* L.) in Hawaii. *Newsletter Hawaiian Botanical Society. University of Hawaii-Manoa*, 15 pp.

Morris, M. (1990). Photoperiodic control of larval development rate in *Planotortrix excessana* (Lepidoptera:Tortricidae): Evidence for larval diapause. *New Zealand Journal of Zoology* 17: 147-151.

Norambuena, H., Carrillo, R. & Neira, M. (1986). Intrduccion, establecimiento y potencial de *Apion ulicis* como antagonista de *Ulex europaeus* L. en el sur de Chile. *Entomophaga* 31(1):39-46.

SAS Institute Inc (1987). *SAS/STAT Guide for Personal Computers.* Edition 6, 1028 pp.

Wilson, F. (1960). Review of the biological control of insects and weeds in Australia and Australian New Guinea. *Technical Communication No 1. Commonwealth Institute of Biological Control Ottawa Canada*, 102 pp.

Zenner-Polania, I. & Helgessen, R.G. (1973). Effect of temperature on instar number and headcapsule width of *Platynota stultana* (Lepidoptera: Tortricidae). *Environmental Entomology* 2: 823-827.